United Nations A/AC.105/1039/Add.10

General Assembly

Distr.: General
22 January 2018

Original: English

Committee on the Peaceful
Uses of Outer Space

Questions on suborbital flights for scientific missions and/or for human transportation

Note by the Secretariat

Addendum

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II. Replies received from Member States

Czechia

[Original: English]
[15 December 2017]

Question (i). Is there a relationship between suborbital flights for scientific missions and/or for human transportation and the definition and delimitation of outer space?

Yes, there is a relationship between the suborbital flights for scientific missions and/or for human transportation and the definition and delimitation of outer space. As the suborbital flights are carried out at a very high altitude, it is questionable to what extent air law or space law applies.

Question (ii). Will the legal definition of suborbital flights for scientific missions and/or for human transportation be practically useful for States and other actors with regard to space activities?

Yes, the internationally agreed definition or description might serve as a starting point for further discussions regarding the suitable legal regime concerning suborbital flights. On the basis of such discussions, States might make use of the current set of provisions relating to said activities or develop new ones, should they find it necessary.

Question (iii). How could suborbital flights for scientific missions and/or for human transportation be defined?

No internationally recognized definition of suborbital flights has been agreed. However, the term as used by the International Civil Aviation Organization might be used as a basis for the discussions, taking into account the wide range of suborbital flights and ongoing technological development.

Question (iv). Which legislation applies or could be applied to suborbital flights for scientific missions and/or for human transportation?

As there is currently neither an internationally recognized definition of suborbital flights nor an agreed legal regime for suborbital flights, and because suborbital flights take place in both airspace and outer space, both air law and space law might be applicable.

Question (v). How will the legal definition of suborbital flights for scientific missions and/or for human transportation impact the progressive development of space law?

Once a definition or description of suborbital flights acceptable to the international community is reached, it might enable States to focus on clarification of applicable legal rules at the international level and on the question of whether development of any specific set of rules, guidelines or recommendations is desirable.

Question (vi). Please propose other questions to be considered in the framework of the legal definition of suborbital flights for scientific missions and/or for human transportation.

No answer.

South Africa

[Original: English]
[12 December 2017]

Question (i). Is there a relationship between suborbital flights for scientific missions and/or for human transportation and the definition and delimitation of outer space?

Yes, there is a relationship. Suborbital flights for scientific missions and/or for human transportation traverse both airspace and outer space due to the nature of these activities. The definition and delimitation of outer space should assist in determining

what legal regime is applicable. The applicable legal regime will outline the related obligations for players.

Hence, it becomes imperative to define or delimit outer space so as to determine whether these flights shall be conducted in accordance with the airspace rules or the outer space rules.

Question (ii). Will the legal definition of suborbital flights for scientific missions and/or for human transportation be practically useful for States and other actors with regard to space activities?

Yes, it will be practically useful, as explained above.

The legal definition will bring about a concise regulatory environment which minimizes the confusion of the airspace and outer space environments.

Question (iii). How could suborbital flights for scientific missions and/or for human transportation be defined?

Suborbital flight can be undertaken using various types of technologies, ranging from those using a single vehicle to those that use a launch vehicle that carries the suborbital vehicle up to an intermediate height before releasing the vehicle to accelerate away and into a suborbital space flight.

Suborbital flight phases can be divided up as follows: powered flight, inertia climb, re-entry, and approach and landing. Suborbital flights therefore comprise paths that are both within an area controlled by an air navigation service provider subject to national jurisdiction, and in space, which is not subject to national jurisdiction. It may therefore be necessary to divide suborbital flight into separate phases.

In addition, the preferred definition could also be structured in order to address the purpose of the mission without trumping the sovereignty issues, as defined in the Convention on International Civil Aviation of 1944.

Currently, the South African Space Affairs Act of 1993 defines "suborbital trajectory" as the trajectory of any object which leaves the surface of the Earth due to a launch but returns to the surface of the Earth without completing an orbit around the Earth.

However, according to the current South African thinking, this definition could be considered: "suborbital flights" for human transportation means the flights that leave the surface of the Earth due to a launch but return to the surface of the Earth without completing a full orbit around the Earth; scientific missions involve probing the atmosphere and/or ionosphere while sending the information to the ground station. The landing point on the surface of the Earth may or may not be on the same territory from which the object was launched.

Question (iv). Which legislation applies or could be applied to suborbital flights for scientific missions and/or for human transportation?

The outer space law applies, although due to ongoing technological advancement, airspace activities could nowadays overlap with outer space activities, considering the Earth's atmospheric blurring of limits. The national outer space laws, civil aviation laws and other multilateral aviation treaties could also apply.

Question (v). How will the legal definition of suborbital flights for scientific missions and/or for human transportation impact the progressive development of space law?

The legal definition of suborbital flights will impact positively on the progressive development of the field of space, as the definition will eliminate the confusion associated with the respective regulatory environment.

Question (vi). Please propose other questions to be considered in the framework of the legal definition of suborbital flights for scientific missions and/or for human transportation.

Suborbital flights raise questions about the applicability of the civil aviation or space law regimes, given the uncertainty as to whether they are aircraft operating as spacecraft or spacecraft operating as aircraft. This could have significant liability

differences given that the civil aviation legal regime provides for territorial sovereignty over airspace, while space law regime prohibits the exercise of territorial sovereignty over any part of outer space. What happens when a suborbital flight traverses a foreign country en route?

This raises a key question of what can be done to harmonize varying national legal regimes in order to minimize regulatory uncertainty for operators. The following are particularly apt:

- If the launching State adopts a legal interpretation different from that of the State in which the object lands, which interpretation should apply?
- Which State takes liability for accidents that transpire in the State in which the object lands? Does the same interpretation used by the civil aviation authorities apply?

III. Replies received from permanent observers of the Committee

International Association for the Advancement of Space Safety[1]

[Original: English]
[9 December 2017]

The present submission examines the relationship between this issue and the definition of suborbital flights for scientific and/or for human transportation. The principal purpose of this paper is to summarize the theories and approaches that have been proposed on this topic and the legal regime(s) that apply to such flights. This paper also proposes a solution to the dilemma as to where the altitudinal lines between airspace and outer space should be drawn, which in turn will clarify the jurisdictional lines between air law and space law.

Functionalism as a means of determining which law applies

The air law conventions apply to "aircraft" and "airspace", although neither term is defined in those treaties. The space law conventions apply to "space objects" and "outer space", although again, these terms are not defined in the treaties. One approach to answer the question of which legal regime governs an object is to examine what kind of object is in question. Is the vehicle an "aircraft", a "space object" or an aerospace object? What is the vehicle's purpose, its activity and its destination? Is the vehicle's primary purpose to go into outer space in order to orbit, to conduct outer space activities (an Earth-space mission), or is it to provide transportation from one point on Earth to another (an Earth-to-Earth mission)? In the former case, arguably it is a space object, while in the latter case, arguably it is not.

Another approach to answering this question is to consider the technological properties, functional characteristics, design and aerodynamics of the vehicle. Is it capable of acquiring lift through the air, for example? Can the object operate without the lift generated by moving through the atmosphere, or without external oxygen to burn as fuel? Once it is categorized as a "space object", arguably space law would apply to it throughout its journey; once categorized as an "aircraft", then arguably air law would apply irrespective of its location.

What is an aerospace vehicle?

With the launch of commercial human spaceflight, the view has emerged that "suborbital vehicles" are a peculiar category of winged crafts that entail functional

[1] The present document contains an abstract of the full submission of the International Association for the Advancement of Space Safety, in English only, which is contained in conference room paper A/AC.105/C.2/2018/CRP.9.

characteristics of both air and space vehicles. This is one configuration of suborbital vehicles similar to the National Aeronautics and Space Administration (NASA) X-15 airplane of the 1960s, but there are other designs with no wings based on capsule/rocket configuration, such as Blue Origin's New Shepard. The International Association for the Advancement of Space Safety has embraced the following definitions:

- *Suborbital flight*: A flight up to an altitude at which the vehicle does not reach orbital velocity.
- *Suborbital vehicle*: Any vehicle conducting suborbital flights per the definition above; this includes reusable launch vehicles and suborbital aircraft.

Commercial suborbital spaceflights likely employ vehicles that reach an altitude above 100 km (the theoretical line proposed by Theodore von Kármán to separate the fields of aeronautics and astronautics) and re-enter the atmosphere of the Earth before achieving orbit around the Earth. This very nature of the suborbital vehicles, coupled with the absence of an explicit delimitation between national airspace sovereignty and outer space prohibition of sovereignty creates a number of questions about the legal nature of such vehicles and the respective application of the appropriate legal regimes. Is it appropriate to categorize winged rocket-powered vehicles as aircraft or spacecraft, or does it require the establishment of a new category of aerospace vehicles with the respective application of both legal regimes that govern aviation and space activities?

In 2016, a definition of "suborbital mission" was introduced by the Range Safety Group through the publication of Standard 321-16, which is meant to reflect the common understanding of the term used since the beginning of space missions. According to this definition, a suborbital flight is defined as any flight of a launch vehicle, rocket or missile that does not achieve orbital insertion. A suborbital rocket is defined as a rocket-propelled vehicle intended to perform a suborbital mission whose thrust is greater than its lift for most of the rocket-powered portion of its flight. Such a definition also is included in the United States Code, as well as in the United States Code of Federal Regulations. Pursuant to this definition, the trajectory and speed of a vehicle, rocket or missile determines whether its flight is orbital or suborbital.

According to such a definition, no univocal link exists between the altitude reached by suborbital flight and the airspace outer space limit. In the region between 18 km (upper limit of managed airspace) and 160 km (lower limit of practically sustainable orbital flights) ("near space"), there are competing national security interests and launch operational needs. As long as such interests and needs remain unclarified, the discussion about delimitation would still remain without a precise answer. Instead, a special regime for that region that recognizes some rights to the countries beneath would probably settle the matter.

Problems with the functionalist approach

Under the functionalist approach, a suborbital vehicle that briefly passes through outer space in the course of Earth-to-Earth transportation would presumably remain subject to air law during the entire journey, but a vehicle that passes through airspace in the course of Earth-to-space transportation might be considered under space law during its entire journey. As the International Civil Aviation Organization (ICAO) has observed, it might be argued from a functionalist viewpoint that air law would prevail since airspace would be the main centre of activities for suborbital vehicles in the course of an Earth-to-Earth transportation, any crossing of outer space being brief and only incidental to the flight.

Because aerospace vehicles share airspace with commercial aircraft, the rules of air safety and navigation must be harmonious. If they operate under two separate legal regimes, the danger of aircraft and aerospace vehicle collision arises. In one sense, the spatialist approach offers greater certainty as to the legal regime applicable, particularly on the rules of navigation governing commonly used airspace.

Nonetheless, demarking where airspace ends and outer space begins has confounded scientific and legal experts for decades.

The United States of America has promulgated laws governing commercial space launches, vehicles, crew, and navigation, vesting jurisdiction in its Federal Aviation Administration (FAA), which has comprehensive jurisdiction over aircraft and aviation safety and navigation. The German Aviation Code also specifies that "spacecraft, rockets and similar flying objects" are considered to be aircraft while in airspace, and thus subject to the prevailing rules and regulations governing aircraft.

Spatialism as a means of determining which law applies

Another way of determining which law applies is to assess where the object is. The issue of where airspace ends and outer space begins has been debated since the 1950s. The Soviet Union's launch of Sputnik in 1957 established the principle of freedom of space: freedom of "access to and unimpeded passage through outer space for peaceful purposes".

The spatialist theory proposes the establishment of a specific delimitation between airspace and outer space, not solely on the basis of scientific findings, for even they lack precision with regards to delimitation. For that purpose, many altitudes of delimitation have been proposed, the most prominent of which is the Kármán line, 100 km above the surface of the Earth, as this is the general area (give or take tens of kilometres) where the atmosphere is so thin that aircraft wings cannot generate sufficient lift for flight, while a spacecraft cannot orbit because the atmospheric drag is excessive.

Problems with the spatialist approach

The spatialist approach poses problems as well. One major problem is that there is no consensus as to where to draw the line of demarcation between airspace and outer space. Yet without such a demarcation, the legal regime remains murky, with different States asserting different sovereignty claims in areas that other States consider outer space, thereby creating potential conflict. Commercial suborbital spaceflights use vehicles that reach an altitude of approximately 100 km, the theoretical line proposed by Theodore von Kármán to separate the fields of aeronautics and astronautics. This line has been recognized by the Fédération aéronautique internationale for aviation records. But setting the boundary of territorial airspace that high would restrict launches to the discretion of the underlying State. Setting the boundary between sovereign airspace and non-sovereign outer space at 100 km would create a wall so high that many smaller and landlocked States would be restricted in their ability to participate in aerospace transportation.

Although both the Convention on International Civil Aviation of 1944 and its predecessor, the Convention Relating to the Regulation of Aerial Navigation of 1919, recognized that States enjoy complete and exclusive sovereignty over the airspace above their territories, neither instrument prescribed how high such a territorial claim could extend. Although the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies of 1967 forbids the exertion of State sovereignty over outer space, it also fails to define the altitude at which outer space begins. Some commentators argue that establishing too high a boundary might hamper certain space activities; once established, it will be difficult to amend, particularly if it should need to be lowered. Moreover, if a legal question arose concerning a flight near the line of demarcation between airspace and outer space, it might be difficult to determine on which side of the line the event occurred.

Another problem is that an aerospace vehicle may enter suborbital space for only a short time, while its primary activity and mission is in airspace. Here we reiterate the point that while current suborbital space tourism vehicles are designed to reach an altitude slightly above 100 km, no matter the altitude, the flight is suborbital so long as the velocity is below 28,400 km/h (orbital velocity). Unmanned research suborbital

flights have been carried out for decades by sounding rockets for a range of altitudes between 50 km and 1,500 km. Military suborbital flights (e.g., intercontinental ballistic missiles or anti-satellite weapons) can reach much higher altitudes.

According to the spatialist theory, everything that operates below the hypothetical delimitation between airspace and outer space would qualify as aircraft, whereas anything that operates above that boundary would qualify as spacecraft. However, what should the approach be for those suborbital aerospace vehicles that principally operate within the air and remain in outer space for less than a few minutes before re-entering the Earth's atmosphere? Under a functionalist approach, it might be more appropriate to apply air law to the entire movement. A spatialist approach might require that vehicles to be certified under, and regulated by, two separate legal regimes: one that is an air law regime created by ICAO, and another that is a space law regime created by some future space navigation organization.

The need for a unified legal regime

Future transportation systems will be highly influenced by the legal regime in which they are developed. Commercial development of space would be much enhanced by clarity, stability and predictability of law. Failing to define the boundary of outer space may "thwart the proper and orderly governance of outer space and the certainty and strength of international law governing space activities." The absence of uniformity of law and conflicting and overlapping laws will impair the market's interest in investment in space transportation and the insurance industry's ability to assess and price risk.

Commercial investment in space transportation systems is expensive, depends on as yet unproved technology, and is fraught with risk. Clear legal rules can help define the degree, or consequences, of risk, and reduce uncertainty, providing the predictability necessary to support commercial investment. Conversely, legal uncertainty can increase risk and chill investment.

Many academics and commentators have urged that legal rules be refined to take account of commercial needs in space. Some have suggested that the emerging legal regime should be one of air law. Others prefer the regime of space law. Still others have urged immunity from liability for commercial activities in space for a developmental period.

Neither "airspace" nor "outer space" is defined in the relevant treaties. The development of suborbital flights would benefit from the delineation of where airspace ends and outer space begins.

"Near space" as a path to a new regime of air and space law

The peculiarities of the suborbital vehicles point to the need for the establishment of a separate, intermediate zone between airspace and outer space. This zone would cover emerging space activities (commercial and military) that use altitudes from approximately 20 km to 160 km, the so-called "near space". Commercial and military interests have begun to develop operating systems in near space. Such systems include suborbital vehicles, stratospheric balloons, pseudo-satellites and high-altitude drones. Some will operate for a few minutes, hours, weeks, months, or years. Some tourism suborbital flights may reach 130 km in order to give its customers more zero-gravity time. Operations in near space are a potential threat for air traffic beneath and for the public on ground in the case of failures or malfunction. They are also a threat for outbound and returning space traffic.

Joseph Pelton, a pioneer in this approach, notes that the area above commercial airspace, i.e., 21 km, and below the area that can allow satellites to stay in orbit above Earth, i.e. 160 km, is finding more and more applications, and space legal experts need to be formally concerned with this region. Uses of this region include stable high-altitude and stratospheric craft such as aerostats, unmanned aerial systems, high-altitude platform systems and so-called "dark-sky" research and relay stations.

The following operational boundaries exist between aviation and space:

- 160 km: lowest practical operating orbit for satellites
- 120 km: re-entry threshold for space systems
- 50 km: upper limit of atmospheric buoyancy (balloons)
- 18 km: upper limit of civil aviation traffic

One alternative would be to define the 50–120 km region (or, alternatively, the 18–160 km region) as "near space", and treat it legally as an intermediate region, as, under the United Nations Convention on the Law of the Sea, we treat the intermediate region between "territorial seas" and "high seas". In particular, innocent passage (commercial activities) would be allowed, but the safety risk for the overflown population should be compliant with international norms (to be defined, presumably by ICAO). The economic exploitation of such a zone should be the exclusive prerogative of the State underneath. Finally, in this region, overflights for military purposes (e.g., intercontinental ballistic missile tests) should be undertaken only if authorized by the overflown country.

Using the jurisdictional zones established by the United Nations Convention on the Law of the Sea as a model, a new treaty, or an amendment to article 12 of the Convention on International Civil Aviation (Chicago Convention) could establish:

- The outer space zone, above 120 km (or, alternatively, above 160 km), subject to Space Law.
- The near space zone, between 50 km and 120 km (or, alternatively, 18–160 km), like a mix of the United Nations Convention on the Law of the Sea Contiguous Zone and Exclusive Economic Zone, open to innocent passage by all, with aerial safety and navigation rules established (presumably by ICAO), enforced by States in flight information regions and States whose aerospace and launch vehicles are subject to air law. It could also be restricted against overflight by foreign State aircraft in the absence of the permission of the underlying State.
- The airspace zone, below 50 km (or, alternatively, below 18 km), subject to the exclusive territorial sovereignty of the underlying State, as that zone is today.

In embracing this approach, a definition and delimitation of outer space would be achieved in an indirect manner, i.e., by establishing and defining the metes and bounds of a middle, intermediate zone, whose lower altitude boundary would mark the end of airspace and whose upper altitude boundary would define the beginning of outer space. In this manner, not only would the activities undertaken within these specified limits be regulated through new laws specifically adjusted to the needs of near space activities, but the establishment of the boundaries of near space would also allow for clarification as to the highest altitude at which air law ceases to be applicable and the lowest altitude at which space law commences. Aside from the easier legal definition and regulation of suborbital activities, Joseph Pelton identifies other issues for which such an approach would provide answers, including safety coordination issues, strategic security, air traffic control management, stratospheric pollution, frequency interferences, satellite navigation software improvements and related technical issues.

What would the benefits of legal clarity be? Predictability of outcomes would be enhanced if the question of whether air law, space law or a new regime of "aerospace law" applied to suborbital flights. Commercial development of space would be facilitated by clarity, stability and predictability of law. Uniformity of law will improve the market's interest in investment in space transportation, and the insurance industry's ability to assess and price risk. Delineation of which legal regime applies — in airspace, near space and outer space — will clarify rights and obligations and enhance the margin of safety for aircraft, spacecraft and aerospace vehicles operating in all three zones.

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